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I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Engineering in Bachelor of Mechatronic Engineering.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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CONTROL OF WHEELED MOBILE ROBOT IN RESTRICTED ENVIRONMENT

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Thesis submitted in fulfillment of the requirements
for the award of the degree of Bachelor of Engineering (HONs) in Mechatronic
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ABSTRAK

Projek ini adalah satu kajian kawalan robot mudah alih beroda dalam persekitaran yang terhad. Sebuah robot mudah alih beroda dengan 3 roda adalah rekaan dan ia adalah kawalan oleh terbitan kawalan daya aktif berkadar (PD-AFC) untuk bergerak dalam persekitaran terhad pra-dirancang untuk melaksanakan ralat sifar landasan yang betul. Parameter kinematik dan dinamik daripada robot mudah alih akan dipertimbangkan. Untuk pengawal, sistem kawalan dengan dua gelung, gelung luar dan dalam direka untuk mengawal robot mudah alih yang beroda. Kabur pengawal logik dilaksanakan dalam SIMULINK untuk menganggarkan Inertia Matrix yang akan digunakan untuk mengira tork sebenar digunakan pada robot mudah alih yang beroda. Robot mudah alih diuji dalam bulat trajektori. Hasil carian telah direkodkan dan dianalisis Walau bagaimanapun, pergerakan robot mudah alih yang beroda di jalan yang sebenar dan jalan yang dikehendaki dibandingkan.

ABSTRACT

This project is a study of control of wheeled mobile robot in restricted environment. A wheeled mobile robot with 3 wheels is fabricated and it is control by a proportional derivative active force control (PD-AFC) to move in a pre-planned restricted environment to perform minimum track error. The kinematic and dynamic parameters of the mobile robot are considered. For the controller, a control system with two loops, outer and inner loop is designed to control the wheeled mobile robot. Fuzzy logic controller is implemented in the SIMULINK to estimate the Inertia Matrix that will be used to calculate actual torque applied on the wheeled mobile robot. The mobile robot is tested in circular path. The results are recorded and analyze. However, the movement of the wheeled mobile robot in actual path and desired path are compared.

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LIST OF SYMBOLS

v	Linear velocity
w	Angular velocity
I	Moment of inertia
τ_i	Torque
I	Inertia Matrix
$\ddot{\theta}$	Angular acceleration

LIST OF ABBREVIATIONS

PID	Proportional-Integral-Derivative
FLC	Fuzzy logic control
AFC	Active force control
WMR	Wheeled mobile robot

CHAPTER 1

INTRODUCTION

1.1 Introduction

Mobile robot plays an important role in society today. There are several types of mobile robot, such as legged, wheeled and tracked mobile robot (Elyoussef, De Pieri, Moreno, & Jungers, 2012). In this technology world, mobile robot became a great helper for human. Wheeled mobile robots are used in many applications especially in factory and some restricted environments that human cannot perform. With the help of the mobile robot, the efficiency to complete a task will be enhanced. For example in production line, robot may shorten the time taken to make the product and reduce manpower (Abdalla, 2013). Moreover, the wheeled mobile robot cannot be use only in factory but it also can be implemented in the road environment. To make sure that the mobile robot will arrive safely in the end point, a pre-planned path is set. The mobile robot is able to follow the planned motion. Many researches are done on the motion control of wheeled mobile robot, such as high tracking accuracy (Deng, Yao, Zhu, Wang, & Yang, 2014).

The motion of the wheeled mobile robot is controlled by controller such as Proportional-Integral-Derivative (PID), Fuzzy logic control (FLC), Active force control (AFC). PID controller is the mostly used controller in industry because of its simplicity (Deng et al., 2014) Besides that, AFC also is a good controller that can minimize the tracking error effectively (Ali, Yusoff, Hamedon, & Yusssof, 2015). By implementing a useful controller, the motion of the wheeled mobile robot will become stable and accurate. Moreover, the mobile robot will be able to move in different types of trajectories with zero track error.

In this research, the Active force control (AFC) algorithm will be implemented to a three wheeled mobile robot to move in different types of restricted environments with zero track error. The motion of the mobile robot is planned and the actual with desired paths of the wheeled mobile robot are compared. Moreover, both kinematic and dynamic modelling of the mobile robot is considered. In this project, it is only focus on the three wheels differential drive mobile robot which will be tested in circular and rectangular path.

1.2 Problem Statement

The main problem of the path control mobile robot is the big tracking errors that occur in its actual trajectory. Nowadays, mobile robot helps the human to do many works, especially some dangerous and repeated works. To control the wheeled mobile robot in restricted environment such as road, and factory; the safety factor should be considered. To prevent collision, the mobile robot should have an approximate zero tracking error performance. From the figure 1, it shows the desired trajectory path and actual trajectory path. The different between desired trajectory and actual trajectory is the tracking error. If the mobile robot does not move in the desired trajectory, collision may occur. Thus, to avoid obstacle collision occur, the mobile robot should move in its planned path with minimum tracking error.

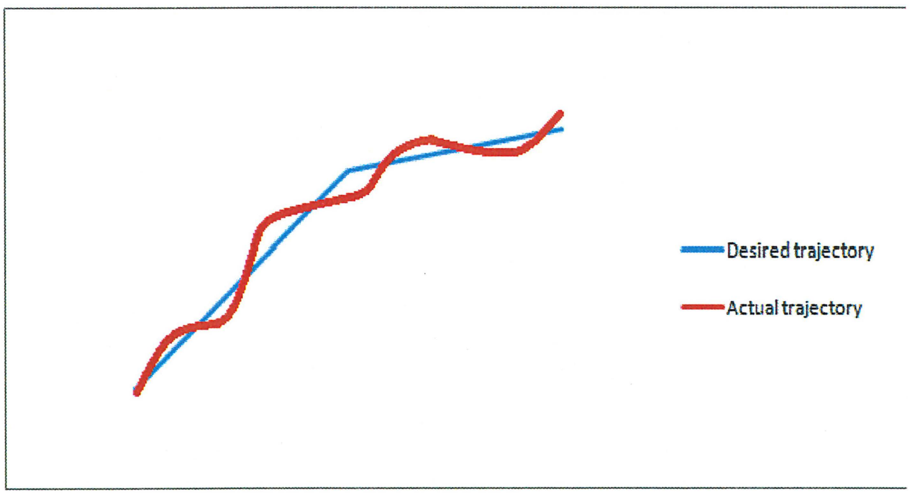

Figure 1.1 Desired trajectory and actual trajectory path of the mobile robot

The next problem of the controlled mobile robot is happed when we use Tele-operated system which controls the robot remotely by human and cause inaccurate control operation of mobile robot. Tele-operated mobile robot control system may need the manpower and some error un-estimated disturbances may occur during the control operation. Therefore, it will affect to the efficiency of the mobile robot to complete their task, where the mobile robot should move in the desired path with a useful controller. An appropriate controller such as PID controller and AFC controller can increase the predictability of the mobile robot's behaviour to decrease tracking errors and can make sure that the control of mobile robot is in robust enough. Besides, it also can speed up the mission of the mobile robot: e.g. in the factory, with the present of these mobile robots, the time taken for the mobile robot to complete the task will be shorter, thus, the productivity will increase. Moreover, a proper controller can increase the efficiency of the mobile robot to complete its task.

1.3 Objective

The main objectives of this work are:

1. To fabricate a three wheeled mobile robot with two differential wheels and one castor wheel.
2. To apply the Proportional Derivative-Active force control (PD-AFC) algorithm with different types of restricted environments.
3. To control wheeled mobile robot in restricted environment with minimum track error.

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